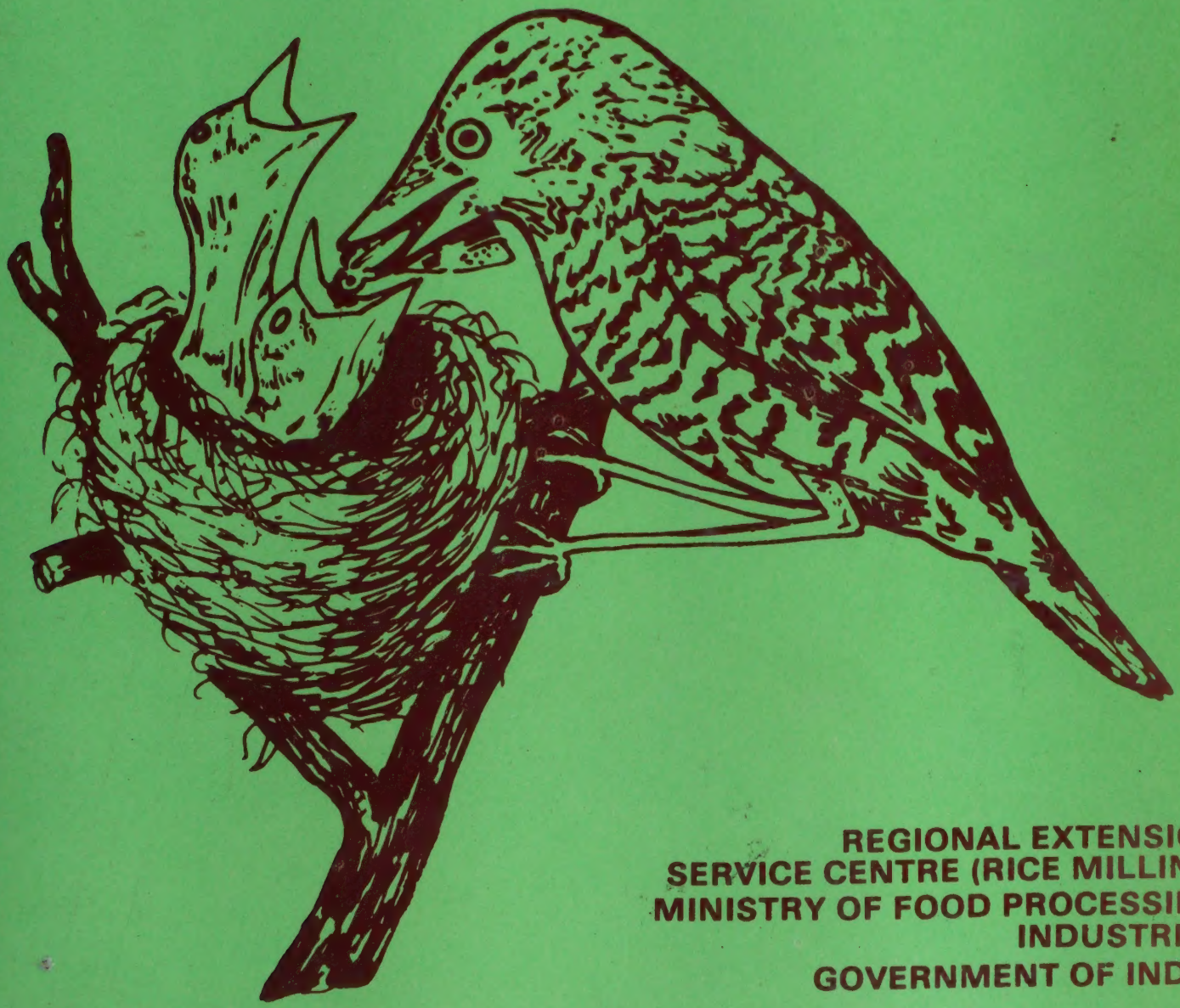
RESC Scientific Series No. 8

WEANING FOODS



REGIONAL EXTENSION
SERVICE CENTRE (RICE MILLING)
MINISTRY OF FOOD PROCESSING
INDUSTRIES
GOVERNMENT OF INDIA

Discipline of Grain Science and Technology
Central Food Technological Research Institute
Mysore — 570 013

15739

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Re[illegible] (Rice Milling)

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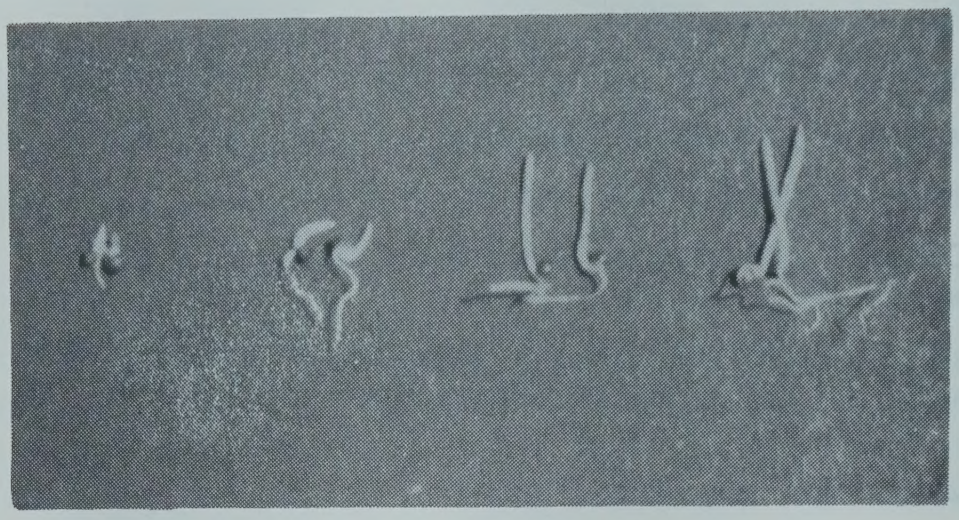
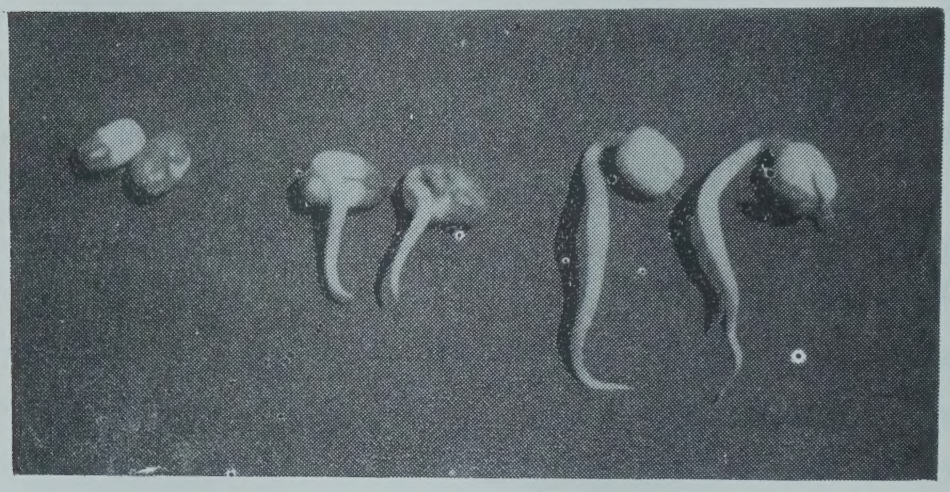




WHAT ARE WEANING FOODS

Human childhood may be divided into three stages: (a) Infancy, (b) Weaning stage and (c) Pre-school stage. Infancy is the period from birth to about 6-8 months of age. The weaning stage lies between the ages of about 4 months and 2-3 years. After this begins the pre-school childhood which ends by about 5 years of age.

In a child's life, each of these stages has its own importance as far as its nutritional needs are concerned. During infancy, the child mostly depends on milk: mother's milk, or in its absence or deficiency, milk from some other source. Mother's milk has all the nutrients essential for good growth and maintaining sound health of the infant.

When the baby attains 4-6 months of age, milk alone is no longer sufficient to meet its nutritional requirements. It needs some more calories and other nutrients as supplement to milk till it is ready to eat fully the adult foods. This is the weaning stage. The semisolid foods given to the child at this stage are generally called **weaning foods.** Weaning foods or these supplements, may be cooked rice or chapati or roti mashed with dhal, vegetables or fruits. Or these may be commercially available brand named proprietary foods, specially prepared for feeding the weaning child, for example, Farex, Balamul, Cerelac and Nestum. Sometimes, mothers prepare special foods like malted or sprouted ragi flour (Wodd ragi), popped cereal flour (Aralhittu or Hurrihittu), mixed with popped bengal gram flour for feeding the child.

The foods that are given to the child at the later stages of weaning period and upto school going age (5 years) are generally adult foods but so prepared as to make them nutritious, easily disgestible, and attractive. These are termed foods for pre-school children.

Why Weaning Foods

The weaning period in a child's life is a very important stage. Many difficulties which arise at later stages have their origin in this stage. The child is exposed to the environment more than before and hence to greater

health hazards. The growth of the child is rapid and consequently its nutritional requirements are increased (see Table 1).

Table 1. Calorie and protein requirements for children

Age group	Body weight (kg)	Daily energy need (k.cal)	Daily protein need (g)
Birth to 6 months	3-7	400-800	7-13
6 months to 1 year	7-9	800-900	13-14
1 to 3 years	9-13	1200-1300	22
4 to 6 years	15-17	1500-1700	29
7 to 9 years	18-21	1800-2100	36
10 to 12 years	23-28	2100-2400	43

Source: Recommended dietary intake for Indians, ICMR, New Delhi (1981).

During the early stages of infancy, the child meets most of its nutritional requirements through mother's milk. Mother's milk not only supplies all the energy, protein and other nutrient needs of the infant but also gives it protection against infections. As the child grows, however, its nutritional requirements are not fully met by mother's milk. Its weight increases, its activity also increases, and it needs more energy than it could get from mother's milk. The availability of mother's milk also decreases gradually. Hence the child needs supplementary (weaning) foods. Mothers know these facts well and therefore introduce supplementary foods, like mashed rice, chapati, roti, dhal or biscuits soaked in milk/tea/coffee, cooked and mashed vegetables/fruits or introduce commercially available weaning foods depending upon what they can afford One should note that it is not sufficient if the child gets enough food but the food must be balanced in energy, protein and other nutrients such as vitamins and minerals. Otherwise, the child may suffer due to shortage of protein

and energy (calorie) resulting in protein-calorie malnutrition. If this condition persists for long, it may lead to diseases like kwashiorkor and if it is not rectified in time, permanent physical disability or even extreme damage may occur.

Availability of Weaning Foods

Several types of weaning foods are being marketed in many countries, including India. The prominent among these are listed in Table 2. They contain about 14% protein and are nutritionally balanced. However, some foods contain less than 10% protein and that too mainly the cereal proteins.

Most of these weaning foods being nutritious blends of cereals, legumes and milk, are excellent supplements to child's milk food, and they are convenient to feed also. But many of the proprietary weaning foods are quite expensive and are beyond the purchasing power of the parents belonging to middle and lower income groups in the developing countries. Due to this, parents belonging to lower income strata feed their children with foods that the adults eat. Generally, adult food in developing countries consists of a high proportion of starchy materials such as cereals and tubers. They are generally low in protein and may not meet the protein needs of the child, especially if enough milk is not available. Further, adult foods normally contain relatively higher levels of fibre and are not easily digestible by the child. Finally, such foods are often quite **bulky** (explained below), due to which the child cannot consume enough food in one sitting as adults can. Therefore even though the child eats enough food and satisfies its hunger, it does not necessarily satisfy its nutritional requirements.

Hence, there is a need to develop weaning foods which may be made available at a relatively low cost, so that even the parents belonging to lower income groups can buy them. Alternatively, there is also a need to develop simple methods to prepare weaning foods using easily available and less expensive raw materials which can be made at household levels, so that mothers can themselves prepare suitable weaning foods for their children.

Table 2. Some popular brands of weaning foods

Name	Produced by	Primary ingredients	Process	Country marketed
Balamul	Kaira District Co-operative Milk Producers Union, Anand	Cereal, Pulse, milk	Roller drying	India
Farex	Glaxo Laboratories	Cereals, milk	Roller drying	India, England, Africa
Cerelac	Food Specialities	Wheat,milk	Roller drying	India, Africa
Nestum	Food Specialities	Rice	Roller drying	India
Faffa	Ethiopean Nutrition Institute, Addis Ababa	Wheat, pea milk, lentil, corn	Dry blending	Ethiopea
Superamine	United Nations Agency	Wheat, chick pea, lentil, milk	Dry blend	Algeria, Turkey
Duryea	Maizena S.A. of California	Soya corn, milk	Dry blend	Columbia
Pronutro	Hind Brothers, Durban	Maize, soya, peanut, wheat, gram, milk, fish flour	Precooked	S.Africa
Incaparina	Quicker Oats Co., Columbia	Maize, cotton seed, soya	Dry blend	Columbia, Gautemala
CSM	American Corn Millers Federation	Maize, soya milk	Dry blend	USA and US food aid countries
Lishe	Tanzania Foods and Nutrition Centre, Dar-es-Salaam	Corn, soya milk	Extrusion cooking	Tanzania
Soya-Ogi	Federal Food Research Institute, Lagos	Soya, cow pea, tapioca	Formentation and spray drying	Nigeria

Desirable Qualities for Weaning Foods

Weaning foods are not foods that are something very different. These are nothing but imitation adult foods prepared by processing the ingredients to make them easily digestible. And of course the food should be balanced and nutritious so that it can promote a healthy growth of the child. The characteristics needed in a weaning food are:

1. the food should be rich in calorie and adequate in protein, vitamins and minerals,

2. the protein should be of good quality and of high biological value,

3. the food when stirred up with cold/warm water or milk should form a slurry or semisolid mass of soft consistency enabling the child to swallow it easily,

4. the food prepared as above should have low **dietary bulk** or viscosity as explained later,

5. as far as possible, the food should be precooked and predigested or processed in such a way, that it needs minimum preparations prior to feeding and is easily digested by the child,

6. the food should be free from antinutritional factors (substances that hinder the digestibility or are otherwise harmful, such as enzyme inhibitors, gas producing factors and toxic components),

7. the indigestible fibre content of the food should be low,

8. it is advisable not to add artificial colours and flavours to weaning foods, and

9. as far as possible, the composition of the food must be as per the guidelines laid down and standards recommended by the Indian Standards Institution or other competent agencies.

In addition, considering the socio-economic conditions of our people, it is desirable to take note of the following points while formulating weaning foods:

i) the methodology used for preparation of the foods should be simple so that it can be made even in homes or at community levels,

ii) as far as possible the foods should be prepared using locally available raw materials, and

iii) the foods should be available at a cost that can be afforded by a large segment of population.

The Concept of Calorie Density or Dietary Bulk of Foods

The value of a processed food depends on its nutrient content (true food) and also on the amount of its nutrients available to the body. A convenient index generally followed to express the nutritional value of a food material is its calorie content. The major nutrients present in foods such as carbohydrates, fats and proteins are digested or burnt inside the body to release energy. The amount of energy released is expressed as calorie. The true food value of different food materials is therefore conveniently measured by comparing their energy or calorific value.

When one gram of fully dried starch is burnt in the body, it produces 4 kilocalories (or 4 Calories) of energy. Similarly one gram of protein yields 4 Calories of energy. On the other hand, one gram of fat or oil gives 9 Calories of energy. Fat has therefore the highest energy giving value. So foods containing more fat have more energy value, or high 'calorie density'.

The other most important factor that contributes to the value of the food preparation is its water content, for water has no calorie value at all. Thus uncooked rice which contains only about 14% water (that is, a solid content of about 86%), has an energy value of a little less than 4 Calories per gram. On the other hand when the same rice is cooked, it absorbs about two and a half times its own weight of water. Therefore now the solid content of cooked rice is only about 25%. As such the energy value of cooked rice is only about one Calorie

per gram. Further, if the same original uncooked rice is powdered and then boiled with water, it will swell more and absorb still more water and perhaps the solid content of the paste will be only 12-16%. The energy value of such cooked rice-paste or porridge will, therefore, be only about 0.7 Calorie per gram of the paste.

The amount of calorie in a quantity or volume of food preparation is called calorie density of the food. This calorie density is therefore a good index for comparing the true value of different foods. As people eat food more by volume than by weight, it is the calorie content per unit volume (one millilitre or one litre of food) that is generally more important than the calorie content per unit weight (one gram or one kilogram of food).

The calorie density is especially important in preparation of weaning foods. The stomach capacity of babies is limited, so they cannot eat beyond a certain amount in one feeding as adults can. There may also be difficulty in feeding the baby too many times in a day. It is therefore important that the calorie density of the weaning food, or the calorie content in the weaning food preparation should be as high as possible. Then the baby will get sufficient calorie and other nutrients in a small number of feedings.

As starch is the major component of any weaning food, the form of starch in the food formulation is very important. For instance if the weaning food contains largely unchanged starch, then the food on cooking with water will absorb a large amount of water and swell greatly, and as a result of which the calorie content of the final food preparation will be very low.

Methods to Increase Calorie Density of Weaning Foods

How then can the calorie density of weaning food be increased? One way to increase the calorie content of the food preparation is to increase the fat content, for fat has a higher calorie density. But fat cannot be increased beyond a certain limit as it may spoil taste, and make the food difficult to digest. Foods with high fat content have poor keeping quality also.

A second possibility is to give the child more solid food, that is, a food having less water such as cooked whole rice or fried or puffed grains. But this is not possible, for babies generally cannot eat adequate quantities of such solid foods.

The third possibility is to partially break down the starch so that it will not absorb much water when cooked. This can be understood by comparing sugar and starch. Sugar and starch are basically similar, but sugar is a small molecule while starch is a giant molecule. Starch is nothing but many glucose (sugar) molecules joined together to form a big molecule. Starch absorbs a large amount of water on cooking and swells up, giving a porridge of a very low calorie density. Sugar on the other hand dissolves freely in water without swelling, so the final syrup has a high calorie density. Therefore if starch is partially broken down to something in between sugar and starch, its swelling tendency is reduced considerably and at the same time the taste is not changed. This can be achieved either by malting the cereals or by adding a substance called enzymes to the starchy food, as will be discussed later.

So, to conclude, one of the important considerations in preparation of weaning foods is to prepare it in such a way that its calorie density is as high as possible. In this way the child can eat a larger amount of true food in one sitting and will have adequate nutrition. If the calorie density on the other hand is low, the child may not get sufficient true food even though it may satisfy its hunger and therefore may suffer from shortage of calorie, protein and other nutrients.

PREPARATION OF WEANING FOODS

As discussed earlier, weaning foods are nothing but adult foods presented in such a way as can be readily eaten and digested by the child. The following three important aspects should be considered while developing the weaning foods. Firstly, the basic raw materials of weaning foods should be locally available food grains. Secondly, the foods should contain low levels of fiber and other materials that are difficult to digest. Thirdly, the foods should be ready to eat or should enable the mother to prepare the gruel or paste from them easily at the time of feeding.

In view of the above requirements, the basic principles of preparing weaning foods are as follows: The grains should be cleaned and dehusked to remove fibrous seed coat. Then they should be powdered, cooked and dried so that a soft paste is obtained when the dried food is mixed or reconstituted with water or milk. Alternatively the materials should be processed or heat treated in such a way as to readily get cooked when they are mixed with water and boiled for a few minutes.

For commercial preparation of weaning foods, the most commonly adopted methods are roller drying and extrusion cooking. Cooking the cereal and legume blend in water followed by spray drying process is also followed to a very limited extent. However, weaning foods can also be made based on some traditional food processing techniques such as malting or sprouting of cereals and legumes, popping and flaking of cereals, chapati making and vermicelli extrusion. The various processes are discussed below.

Modern Technologies

Roller drying

Preparation of weaning foods by roller drying method is extensively practised throughout the world. All the four brands of proprietary weaning foods marketed in India are prepared by this technique.

Polished rice or wheat flour is mixed with bengal gram or deoiled soya flour, sugar and milk powder. The blend is mixed with cold water (about 30% slurry) and homogenised. The slurry is allowed to flow on two stainless steel drums heated by live steam (about 5 kg per square centimeter pressure) and rotating in opposite directions at 3-10 rpm. In the process, the ingredients get cooked and dried at the same time on the drums and the product is collected in the form of flaky material. It is powdered and blended with vitamins and minerals and packed in air-tight tins (see Figure 1).

The process has many advantages:

i) it allows for the use of a wide range of raw materials,

ii) the fibre content of the food can be regulated by using polished or refined grains,

iii) the finished product is fully precooked and hence needs no separate cooking prior to feeding,

iv) the product mixes well when stirred up with water or milk and becomes a soft mass,

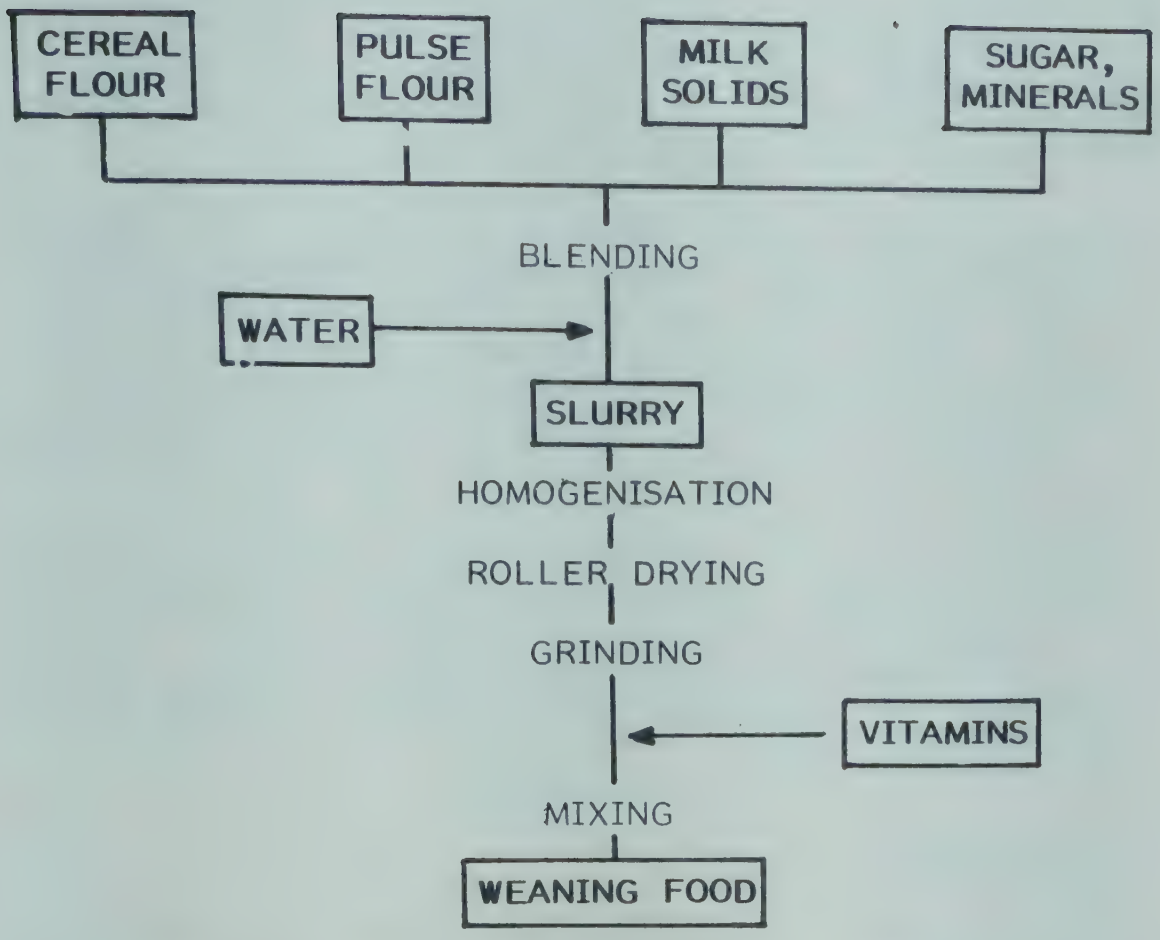
v) the heat treatment generally reduces some of the antinutritional factors and improves digestibility, and

vi) the process permits mixing of additional desirable nutritious ingredients (such as enzymes, sugars and flavour after roller drying).

However, the process has some disadvantages also:

i) the product is fluffy and is very light in weight. Therefore it needs rather a large package,

ii) the product is somewhat hygroscopic (absorbs moisture or water when exposed to high humidity or damp atmosphere). Hence it needs to be packed in tins or other packaging materials that protect it from entry of moisture. Such packaging is expensive and increases the cost of the product.



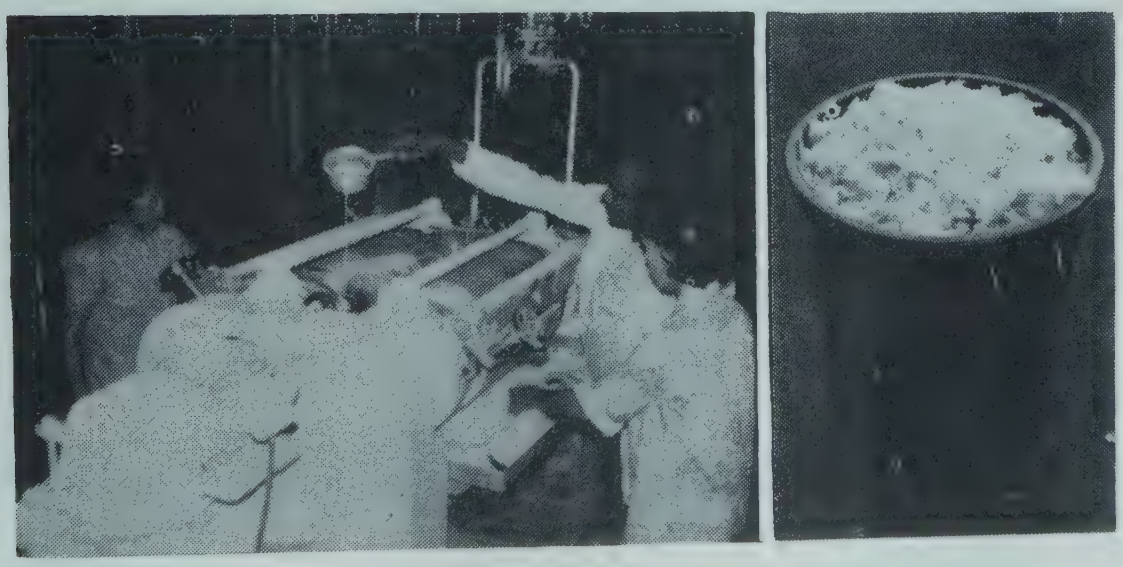


Figure 1. Flow chart of roller drying process for production of weaning food (top), roller dryer and roller dried weaning food (bottom).

iii) the product absorbs a large quantity of water when prepared for feeding, and becomes bulky (however, the dietary bulk of the food can be reduced using malt enzymes. This aspect will be discussed later),

iv) the severe heat treatment given to the ingredients during roller drying slightly reduces the nutritional quality of the food proteins, as lysine, the nutritionally important protein component binds with sugars and becomes unavailable. (Lysine is one of the amino acids. Many amino acids join together to form the protein),

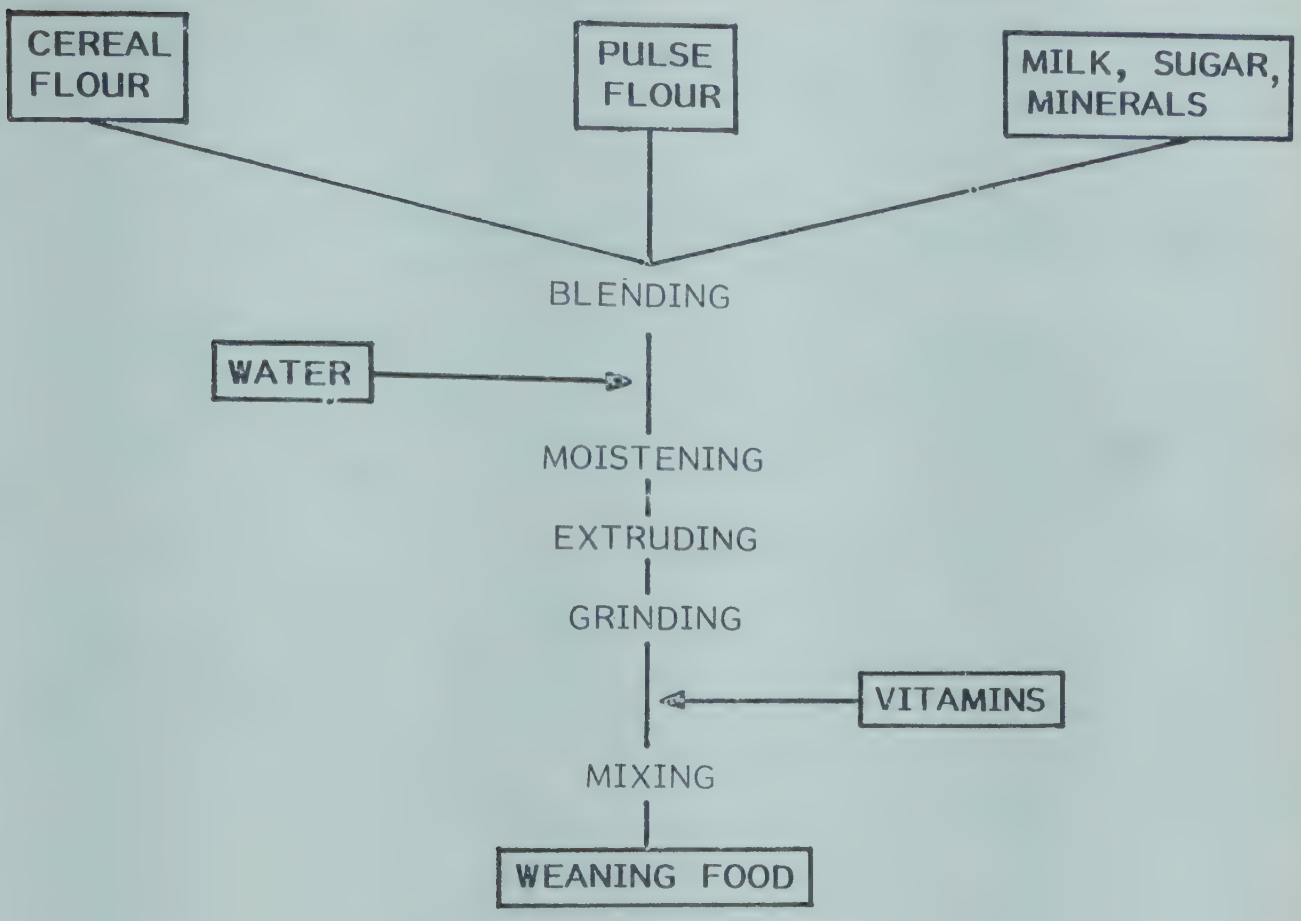
v) moreover, the process involves use of sophisticated and expensive machinery requiring high capital investment. It requires strict control of process variables and skilled manpower. Therefore its production is possible by big entrepreneurs only.

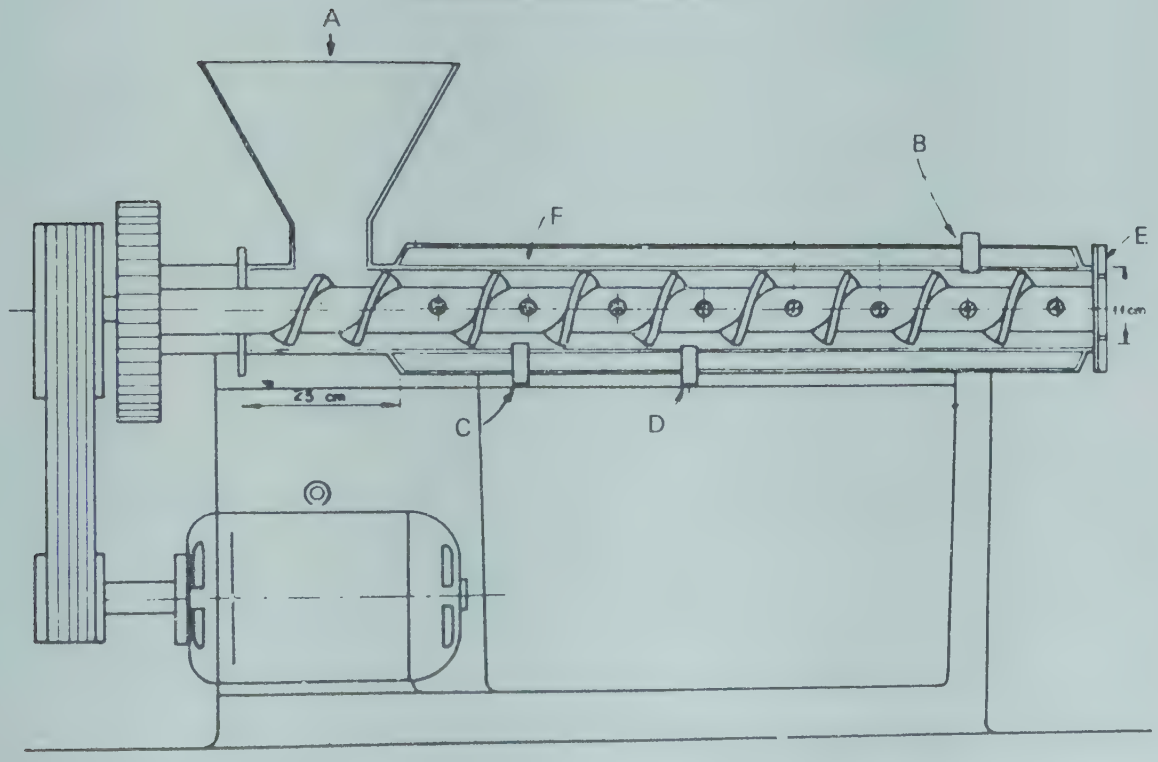
Extrusion cooking

This is also a modern food processing technology adapted to produce weaning foods. An extrusion cooker is basically a pump that simultaneosuly transports, mixes, cooks, cuts, stretches and shapes the material under high pressure and temperature. Extrusion cooker consists of one or two screws which rotate in a tightly fitting barrel with a disc, having provision to fit a die of desired shape at the outlet. The ingredients for the weaning food (cereal flours, legume flours, milk and sugar mixed together) are moistened to contain about 20% moisture and the mixture is fed to the extruder. It begins to be compacted and gets heated (about 120°C) due to high friction. So the material gets cooked and thoroughly mashed .and finally comes out through the die in the form of dry fluffy strip. The product is powdered and blended with necessary vitamins (see Figure 2).

Extrusion cooking is a versatile process. The product is fully cooked and ready to eat. It mixes easily with milk or water. As in roller drying, the process permits the use of a variety of ingredients as desired. Since drying step is almost avoided, the process is economical as

Figure 2. Flow chart of extrusion cooking process for preparation of weaning food (top) and schematic diagram of an extrusion cooker (bottom).





A - Feed
B - Steam injection
C - Water injection
D - Steam injection
E - Plate with outlet hole
F - Steam jacket

Source: Filho, F.P., Germany, C.J. and Melo, G. A. Lavoura Arrozeira, 27, No.280(1974), p.4-11

compared to roller drying. But the equipment is very expensive. The process has almost all the advantages and drawbacks that the roller drying process has.

Preparation of Weaning Foods Based on Some Traditional Technologies

As explained earlier, mothers can slightly improve the texture and enhance the nutritional quality of the foods commonly prepared in homes, for feeding the weaned infants. Some of these simple technologies are described here.

Malting of cereals and legumes

Malting is one of the traditional methods of food processing. The process of malting is simple and has many technological and nutritional advantages for weaning food preparation. As indicated earlier, the use of malted or sprouted grains in child feeding preparations is practised. But most mothers generally feed malted cereals only. To make the malt food nutritionally complete, it should be mixed with protein rich materials such as malted or toasted legumes. The methods of preparation of malt flours from cereals and legumes suitable for use in weaning foods are given here. Among Indian cereals and legumes, ragi and green gram posses some special characters with regard to their malting qualities and suitability for preparation of weaning foods. Hence, various steps involved in malting of ragi and green gram in detail are discussed below:

MALTING OF RAGI

Malting of ragi (finger millet) for food uses is practised from time immemorial. Malted ragi or Wodd ragi is used to feed young children. Ragi has certain merits for malting over other tropical cereals such as rice, maize, jowar and bajra. Ragi contains high levels of calcium and its protein is rich in methionine, a sulphur containing amino acid. Malting of ragi does not pose problems such as mould growth as is observed with jowar or bajra. Ragi malt has acceptable taste, desirable aroma and keeps well for quite some time.

Methodology generally followed to prepare ragi malt at household level is as follows:

Cleaned ragi (1-2 kg batch) is soaked in water for 5-15 hours. Excess water is removed and the soaked grains are wrapped or tied in cloth and left for germination for 1-3 days. Water is sprayed during germination to keep the grains moist. Sprouted grains are dried, mildly toasted and powdered (the rootlets are generally not removed). The meal is sieved through fine mesh sieve or cloth and the fine flour (malt) is collected and stored in tins. The malt flour is cooked in the form of porridge or slurry and fed to the child. Many mothers, instead of sieving, disperse the powdered malt in excess water and collect only the starchy material that settles below, cook it and feed the child. This method of preparation of malt flour has a few drawbacks, such as:

i) steeping ragi for less than 10 hours is not sufficient to hydrate the grains fully as required for proper germination,

ii) wrapping the soaked grains tightly or tying them in cloth prevents proper germination or sprouting, because it affects aeration and rootlet development. Germinating grains respire (breathe) rapidly, which results in release of carbon dioxide and heat. Therefore, the released carbon dioxide should be removed and fresh air should be made available for proper germination. Moreover, the growing rootlets form a tight mass and prevent free entry of air, hence the malt prepared following this method of germination (tying) is of inferior quality,

iii) it is not advisable to grind the germinated grains after roasting along with the roots and shoots. Roots and shoots increase the fibre content of the food and also make the food taste slightly bitter,

iv) grinding the toasted malt as such and sieving the finely powdered malt through fine sieve or cloth results in very low yield of malt flour. On the other hand if sieving is done through

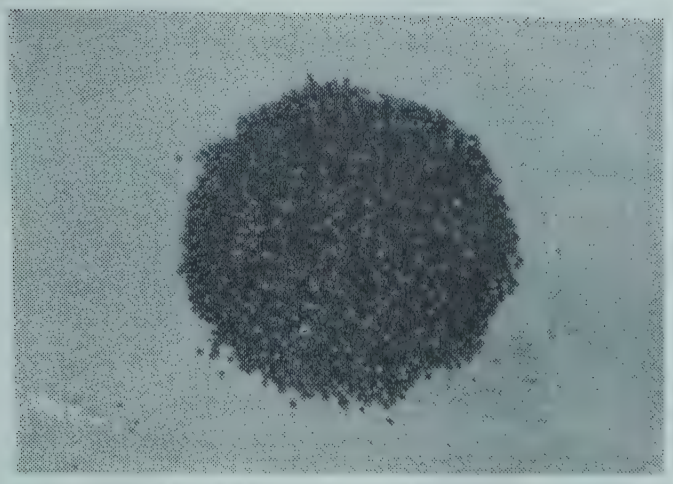
sieve of bigger openings, the malt flour would contain fine bran particles or in other words, it contains more fibre,

v) when the malt powder is dispersed in excess water and only the starchy portion that settles below is collected, water soluble nutrients of malt (vitamins, minerals, sugars, amino acids) are lost. Moreover some of the malt enzymes (see later) are also removed along with the water.

Considering all these points, the recommended method for preparing ragi malt for use in weaning food is as explained below:

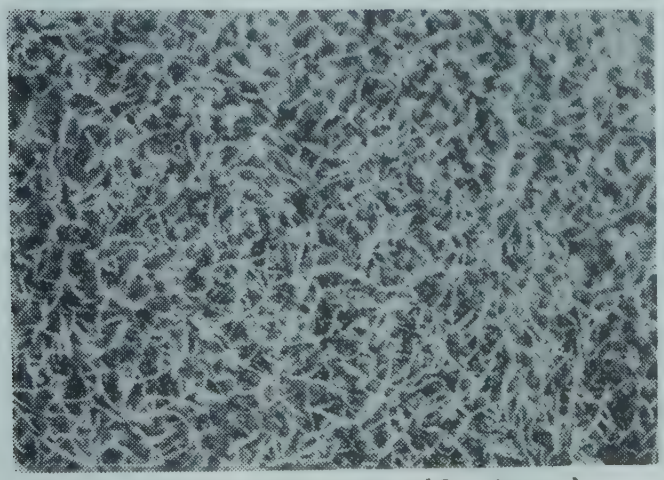
Steeping or soaking: Cleaned ragi is washed in excess water (see Figure 3). Washing removes adhering dust, immature grains and also the pericarp to some extent. Washed grains are soaked in excess water. Soaking for about 16 hours (say from 4 pm to next morning 8 am) is ideal. Ragi soaked in this way contains about 35% moisture, which is optimum for good germination. Soaking for lesser time results in uneven germination. Soaking for longer time does not give any added advantage but, on the other hand, it causes more loss of solubles. The water should be changed once or twice during the soaking period. Changing the soak water helps to remove the trapped carbon dioxide, the leached (washed out) soluble matter, and reduces the growth of microbes and prevents development of bad smell. At the end of steeping period the grains are again washed, the excess water is removed and are spread for germination.

Germination: Soaked grains should be spread on moist cloth or gunny to about 2-3" thick bed, then covered with another moist cloth or gunny. However, if a large quantity is to be germinated, it can be spread directly on the floor and need not be covered. Covering helps to keep the grains moist and facilitate uniform germination. During germination, water should be sprinkled occasionally to keep the sprouts moist, but spraying of excess water should be avoided. The seeds spread for germination should be turned and mixed up once a day. This helps in better aeration and prevents. clogging of rootlets of sprouts.

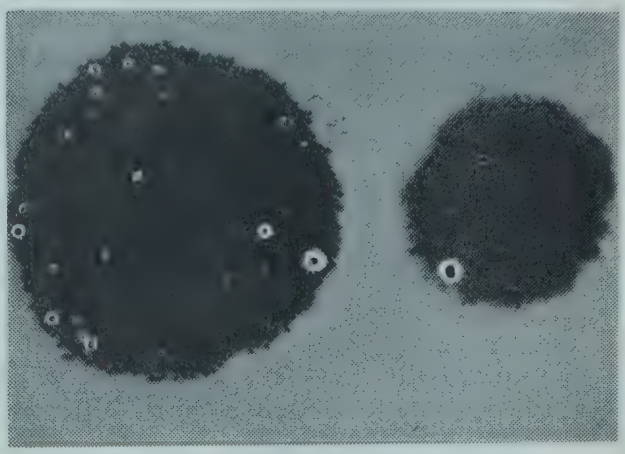


1. Ragi (finger millet) seeds

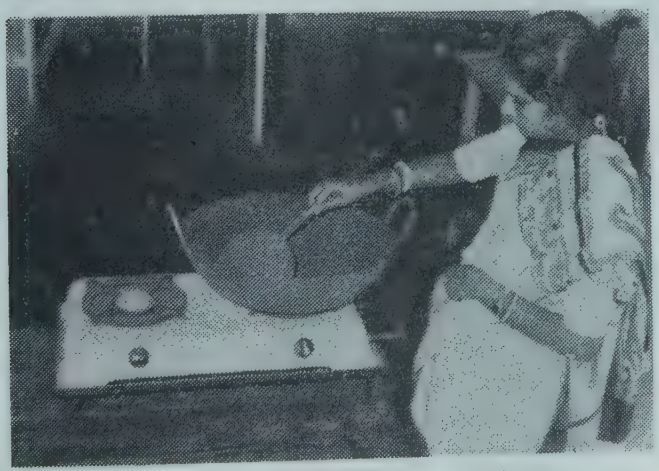
2. Washing and soaking



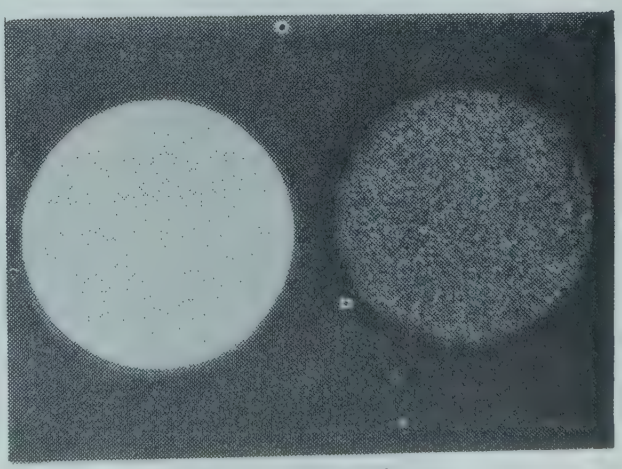
3. Germinated ragi (2 days)



4. Vegetative portion and devegetated malt



5. Kilning or mild toasting



6. Malt flour and bran

Figure 3. Malting of ragi

Two days germination period is sufficient for ragi. If germination is continued for more than two days, roots and shoots grow very long and cause high malting loss (see Figure 3). Ragi germinated for two days has adequate levels of starch hydrolysing enzymes (see below), and thus germinated ragi is easily disgestible as compared to ungerminated grain.

During germination of grains a set of enzymes that are useful for digestion of food develop. Important among them are starch, protein and oil (fat) digesting enzymes. Starch digesting enzymes are known as amylases. Protein and fat digesting enzymes are termed as proteases and lipases respectively. Cereal grains contain about 60% starch and therefore amylases play a very important role in malting. Starch is made up of units of glucose, a sugar. During germination a portion of starch is broken down into glucose, maltose (another sugar) and multiple units of these sugars. During heating or cooking the slurry of malt flour the enzymes present in the malt further digest most of the starch that is not hydrolysed during malting. This actually helps in thinning down the slurry or reducing the dietary bulk of food.

Drying: After germination, the sprouts are dried. Drying can be done either in sun or mechanically with hot air. When the sprouts are spread thin under a clear sun, 4-5 hours are enough for fully drying. A simple way to test whether the sprouts are dried properly or not, is to take a few sprouts and rub them in the hand. If the rootlets get separated and powdered easily, drying is complete.

Devegetation: Dried sprouts should be devegetated, that is, the roots and shoots should be separated from ragi. It is better to do this immediately after drying, when the rootlets are dry and brittle and separate easily. Otherwise, if left overnight, the rootlets will absorb moisture from the atmosphere and become slightly soggy, then it will be difficult to remove. The sprouts can be devegetated by simply rubbing them by hand against gunny and then separated by winnowing off. If a large quantity of ragi is sprouted then the dried sprouts may be devegetated in a rice huller. While doing so, care should be taken to adjust the feed rate and outlet so that malted

ragi is not crushed and only rubbed to separate the rootlets. The pulverised rootlets usually pass through the bottom screen of the huller. Any rootlets coming with the grain can be removed by air aspiration. The sprouted grains, after drying and devegetation are called green malt.

Kilning: Kilning means mild toasting or curing of the green malt. Pleasant flavour and aroma are developed during kilning. It also improves the taste of malt. The green malt can be kilned on a frying pan heated by a low flame (see Figure 3). But care should be taken to agitate the malt continuously. The temperature reached by the material should be about 70°C (it can be felt by hand touch). Kilning can be done more effectively in a coffee roaster where the temperature of the material is well controlled and the grains are continuously agitated and mixed.

Moisture content of the green malt should be around 14% prior to kilning. If the moisture content is more, the malt becomes gritty (like sand) and its milling quality is affected, although such malt is sweeter than the malt kilned at about 14% moisture. On the other hand, malt kilned at a moisture level lower than 12% develops poor flavour. A kilning temperature higher than 70-75°C destroys the enzyme activity of the malt and hence affects the thinning of the prepared food slurry.

Debranning of malted ragi: As discussed earlier, the fiber content of the weaning food should be as low as possible. Therefore, it is necessary to debran or refine malted ragi to obtain flour with minimum bran content. Ragi cannot be dehusked or polished with rice milling machine, for its inner grain is soft and breaks easily. However, the husk and bran can be easily removed by wetting, grinding (powdering) and sieving. When the grain is wetted with a little water, the husk becomes leathery. So, if the wetted grain is ground, the inner grain gets easily powdered but the leathery husk cuts into big pieces. When this mixture is sieved, the husk, which is in big sizes, can be easily separated. This is the principle of preparing refined ragi malt flour. Hence, in practice, to obtain the refined ragi malt flour, the kilned malt should be sprayed with about 7% moisture (one tea cup full water for about 2 kg malt) and uniformly mixed. The

sprayed malt should be heaped up and left for about 10 minutes for the water to be absorbed by the seed coat. It is then ground in a plate mill or in a hammer mill or in any other similar mill and sieved through about 60 mesh sieve (a sieve of a little finer mesh than normally used in home to sieve wheat or jower flours). The husk or bran remains on the top of sieve and flour is collected at the bottom. The flour thus obtained is ragi malt flour.

The debranned ragi malt flour is generally poor in protein (about 5%) and its lysine content is also low (lysine is one of the amino acids essential for good utilization of the proteins in the food). Therefore, it needs blending with other high protein food materials, such as legumes (pulses, dhal), oil seed cakes, milk powder or other animal proteins. This enhances protein content of the weaning food and also mutually makes up the amino acids that are low in the two proteins, upgrading the overall nutritive value of the food. Mixing malted ragi with pulse flours is more appropriate as pulses are readily available at a reasonable cost, whereas, milk powder or animal proteins are expensive and edible grade oilseed cakes are not easily available. Pulse or legume proteins complement the ragi proteins well and hence the deficient amino acids in each of them are made up resulting in a nutritionally balanced food mix.

The common pulses used in India are bengal gram (C anna) green gram (Moong), cow pea, black gram and tur (Arhar). Their protein content is about 22% and the protein is rich in lysine. Blending ragi with any one of these legumes in about 2:1 ratio makes a good nutritive blend. But pulses contain some antinutritional factors, such as trypsin inhibitor (trypsin is an enzyme that helps in digestion of protein, but some factors present in legumes oppose the trypsin activity and are known as trypsin inhibitors), flatus or gas producing factors (some sugars called oligosaccharides and indigestible starch produce gas a few hours after eating and cause stomach pain or inconvenience), and haemagglutinin, a factor that inactivates red blood cells. Fortunately, heat treatment of legumes reduces the antinutritional factors and also improves digestibility and taste. However, the levels of these antinutritional factors vary among the legumes and green gram is known to contain the least levels of these undesirable

factors. Besides, the proteins and carbohydrates of green gram are easily digestible, as compared to other legumes. Among the different processing techniques, germination or malting of legumes improves the availability of minerals, reduces the antinutritional factors, enhances some of the vitamins and improves the overall nutritive values. Therefore malted green gram is an ideal source of protein rich material for blending with malted ragi to prepare a nutritive blend for use as weaning food.

MALTING OF GREEN GRAM

Malting of green gram is similar to that described for ragi. Cleaned grains should be washed and soaked in excess water. The grains become almost double in volume, hence the soaking vessel should be big enough to accommodate the swollen grains. Soaking water should be changed once or twice. Soaking for 10-15 hours is sufficient. At the end of soaking period, the soaked grains should be washed gently, because, due to swelling the husk is loosened and the two cotyledons (split dhals) are also loosely held and may separate if pressure is applied which would harm the germination. Later the steep water is removed and the grains are spread on moist cloth for germination. Water should be sprinkled during germination occasionally to keep the grains moist. Germination for one day is sufficient. Continuing germination for more than one day does not give any advantage, on the other hand it leads to excessive malting loss due to seedling growth and imparts slightly bitter taste due to break down of proteins.

The sprouts should be dried to stop the germination. This can be done either by sundrying or by mechanical drying. Wet sprouts contain about 60% moisture, and they need to be dried to about 12% moisture. Therefore, drying of green gram needs a slightly longer time than needed for drying of ragi. In a clear sunny day, drying may take 6-8 hours. Drying in one stretch is desirable. If partially dried sprouts are heaped and left overnight, the product becomes slightly bitter.

The dried sprouts are then dehusked and split in one operation. This can be done in a plate mill or in a rice huller. Swelling of the grains during steeping and shrinking during drying loosens the husk and therefore

a slight impact is enough to detach the husk and rootlets. Simultaneously, splitting of the cotyledons also takes place. Dhal is separated from husk and rootlets by winnowing or by aspiration (see Figure 4). To improve the taste, flavour and keeping quality the dhal is toasted under mild heat till a pleasant flavour is developed and the colour is changed to light brown. Finally the kilned dhal is powdered to get green gram malt flour.

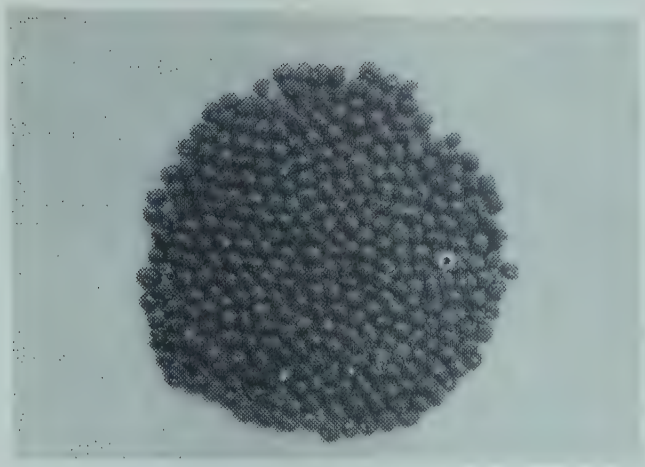
BLENDING OF MALTED RAGI AND GREEN GRAM FLOURS

Two parts of ragi malt flour is mixed with one part of green gram malt flour to obtain the weaning food (see Figure 5). This could be further fortified or enriched with skim milk powder, vitamins and minerals, if desired. The mix is generally called as **malted weaning food.**

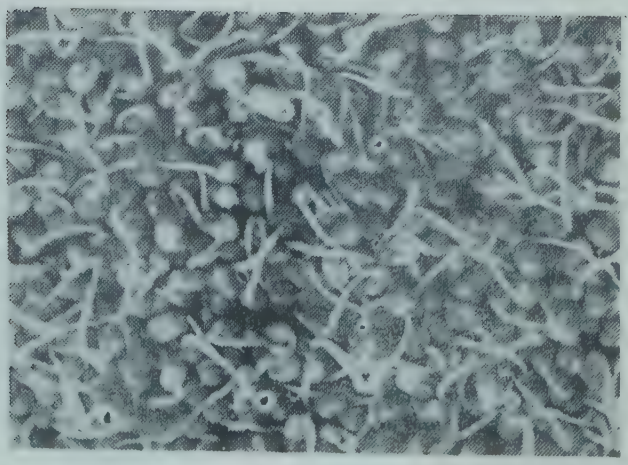
Composition and nutritive value of malted weaning food: Malted weaning food contains 12-14% protein. Its composition generally compares well with that of popular brands of weaning foods (see Table 3). The composition is more or less in the lines of standards laid down by National and International Agencies for similar foods.

If the weaning food is produced on commercial scale, then to enhance the food quality and also to make up the loss on storage, it may be fortified (addition of external nutrients) with 5-10% skim milk powder, 5-10% sugar, necessary vitamins and minerals as shown in Table 4.

The malted weaning food exhibited good growth promoting value when fed to laboratory animals and also to children. The PER (protein efficiency ratio, that is, weight gained by young rats for every gram of protein eaten) is 2.4 (the PER for a very good quality protein like skim milk powder will be about 3.0). The food protein has high biological value (that is, it is readily absorbed by the system in the body). The food was fed to children of age group 4 months to 3 years over a period of six months continuously & it was found that the overall growth of the children receiving malted weaning food as a supplementary food (that is, food given in addition to milk and meals) was very good. The children liked it more than the roller dried proprietary weaning food. Malted weaning food does not absorb water from the atmosphere quickly and so can be packed in polypropylene pouches



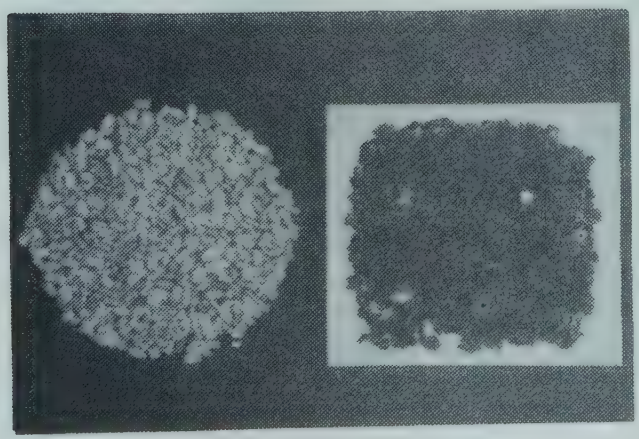
1. Green gram (moong) seeds



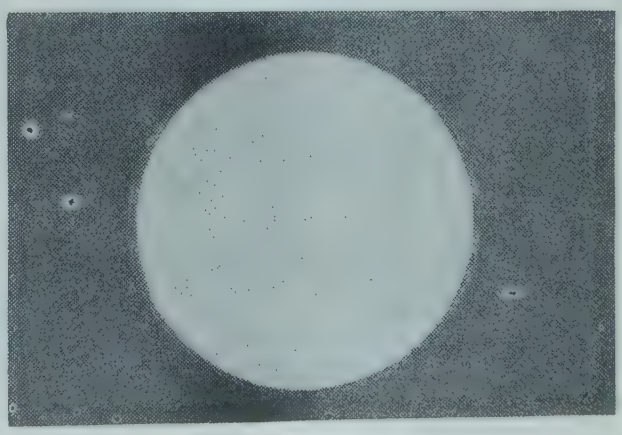
2. Germinated green gram (1 day)

3. Drying of sprouts under sun

4. Separation of dhal and husk



5. Dhal and husk containing rootlets



6. Malt flour

Figure 4. Malting of green gram

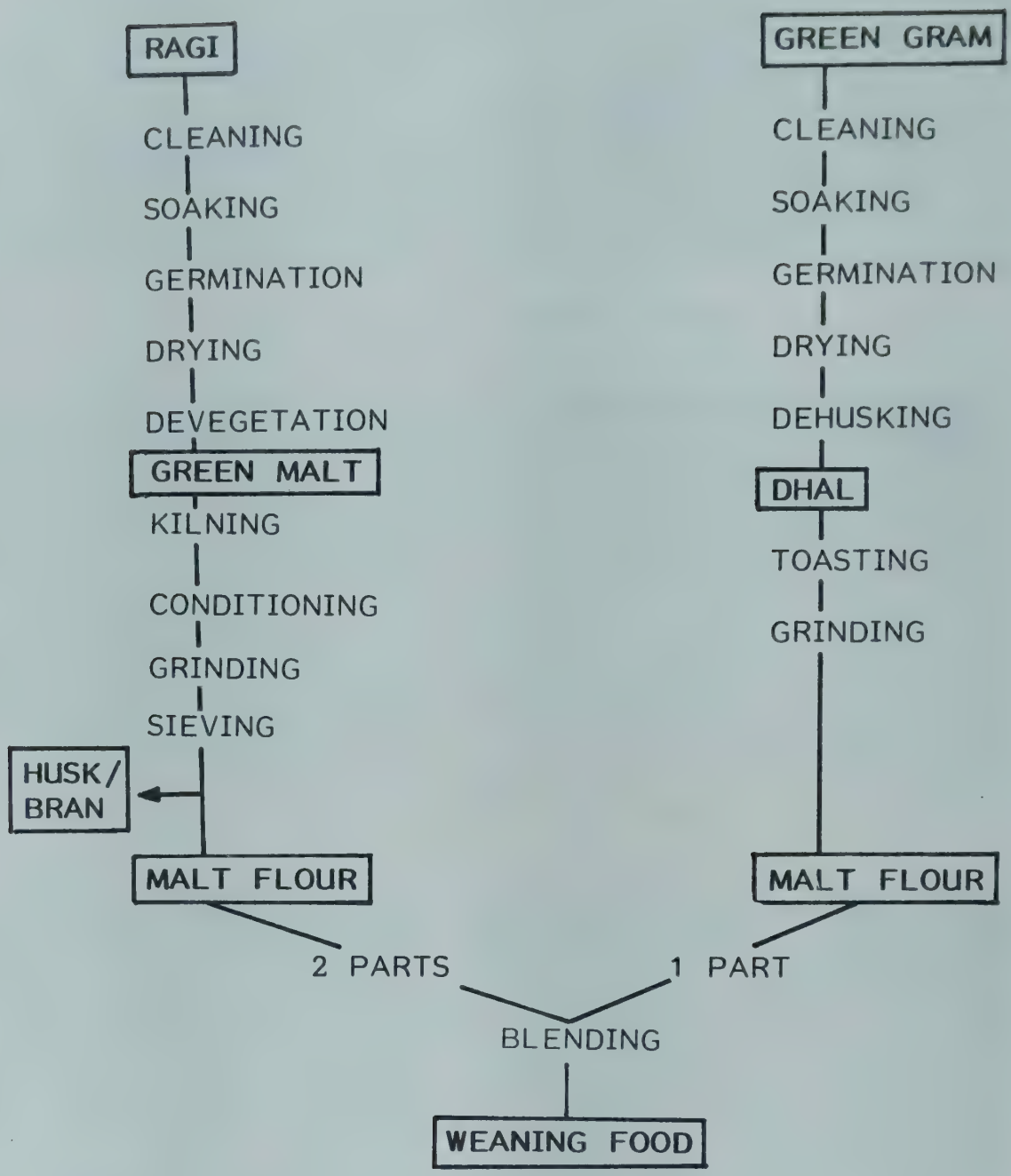


Figure 5. Flow chart for preparation of malted weaning food based on ragi and green gram

Table 3. Composition of malted weaning food

Constituents	Per 100 g
Moisture (g)	6.0
Protein (g)	12.0
Fat (g)	2.0
Crude fibre (g)	2.0
Carbohydrates (g) (by difference)	76.2
Total ash (g)	1.8
Phosphorus (mg)	210
Calorie	396
PER*	2.4
Bulk density (grams per litre)	570

* Explained in the text.

Table 4. Recommended levels of vitamins and minerals for fortification of malted weaning food

Vitamins	Quantity to be added to 100 kg of food	Concentration achieved in food
Vitamin B_1	1 g	1 mg%
Vitamin B_2	1 g	1 mg%
Vitamin C	50 g	50 mg%
Vitamin A	15,00,000 IU	1500 IU%
Vitamin D	4,00,000 IU	400 IU%
Folic acid	100 mg	100 mcg%
Vitamin B_{12}	0.5 mg	0.5 mcg%
Ferrous sulphate	75 g	15 mg% (as Fe^{2+})

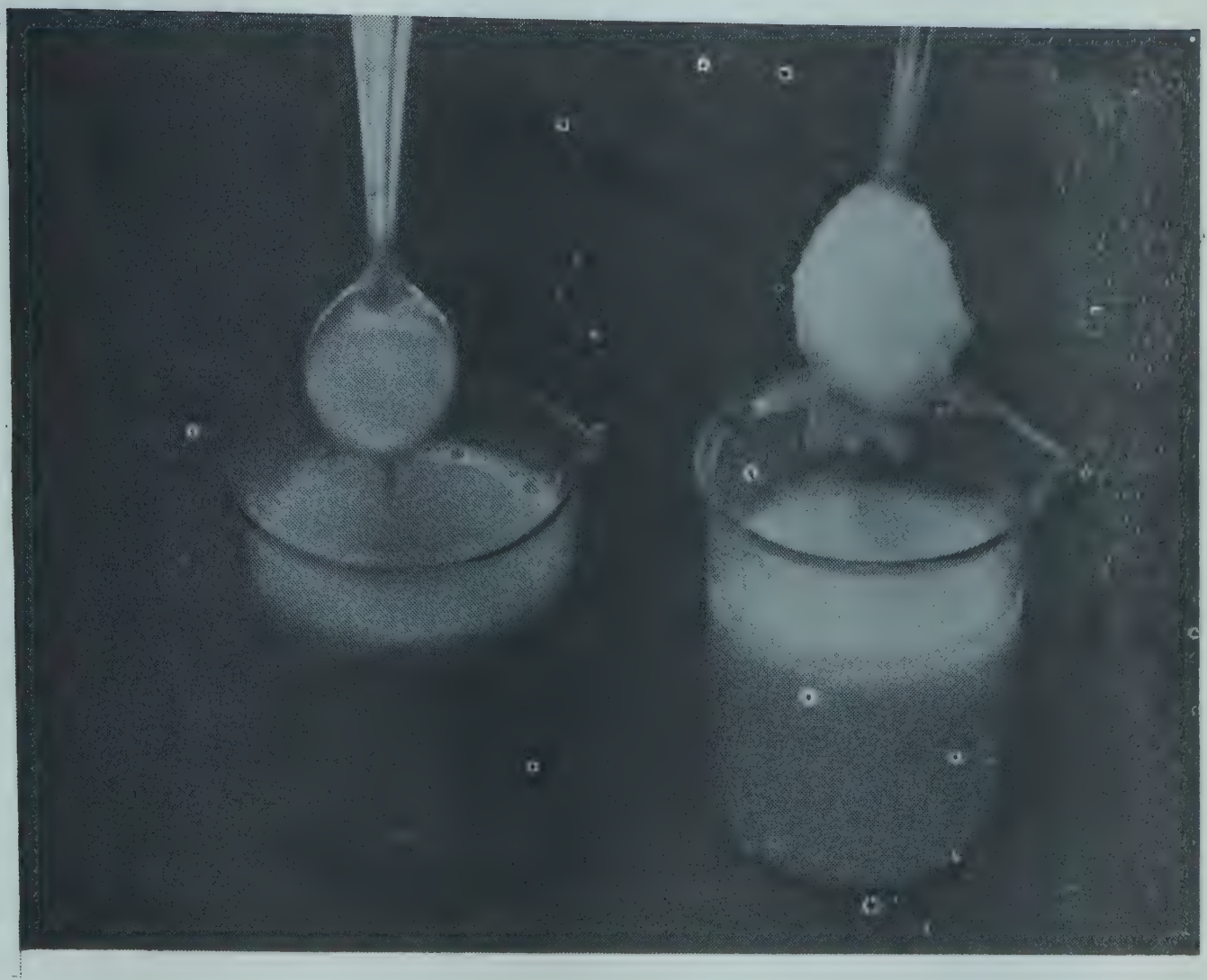
for local distribution. However, for transportation to distance places and distribution at high humidity and high temperature climates, it is advisable to pack the food in laminate pouches. The food can be stored for atleast 2-3 months under ordinary conditions without spoiling its quality.

Unlike proprietary weaning foods, which are precooked and are ready to eat, the malted weaning food is not fully cooked, hence needs cooking prior to feeding. The food should be stirred up with cold water (about 5 tea spoonful in a cup of water or milk), heated slowly to boiling and finally boiled for a minute or two. Slow heating enables the malt enzymes to hydrolyse (break down) the starch, which results in thinning of the slurry after cooking. One can say, in other words, that the viscosity, that is. the thickness or swelling, of the food slurry will be low. Hence, for equal slurry thickness of the food prepared, as compared with the roller dried foods, the child receiving malted weaning food gets a greater amount of food solids, that is, higher levels of calorie and nutrients (see Figure 6). Cooking also destroys most of the micro-organisms that contaminate the food and water.

The malted weaning food is easy to digest and nutritionally balanced and it does not produce gas after eating. Hence it can also be taken by old people and during or after illness.

PRODUCTION OF MALTED WEANING FOOD ON COTTAGE/SMALL SCALE INDUSTRY LEVEL

Ragi and green gram should be first tested for their germinability or viability, that is for per cent germination. Only living grains can germinate. As germination is a must for making malt, previous test of germinability of the grains is essential. Both ragi and green gram (cleaned) should show at least 95% germination. The grains should be cleaned prior to soaking. Cleaning may be done manually or mechanically using a destoner. For steeping, cement or steel tanks may be used. During steeping the grains should be agitated slowly for proper aeration and swelling. It is better that a continuous flow of water is maintained to the steeping tanks. Otherwise the steep water should be changed once or twice during steeping period.



Malted weaning food **Roller dried weaning food**

Figure 6. Consistency of malted weaning food and roller dried weaning food pastes containing 15 g food in 100 ml water

Major equipments and machinery required:

1. Destoner
2. Air aspirator
3. Steeping tanks/bins
4. Germination trays/boxes
5. Humidifier/water sprayer
6. Drying yard/hot air dryer
7. Rice huller/polisher/pearler
8. Cake/coffee roaster
9. Water mixer
10. Grinder (plate, hammer or roller mill)
11. Sifter

    Note: If the mini grain mill developed by the CFTRI (see Figure 7) is used, operations involving equipments mentioned in item Nos. 9,10 and 11 could be done in one operation.

12. Baffle mixer or planeary mixer
13. Packaging machines
14. Fumigation chamber

Equipments needed for quality control laboratory:

1. Germination or viability testing equipments
2. Moisture meters (to measure the water content of the grains)
3. Viscometer (Brookfield make, to measure viscosity [thickness] of food slurry)
4. Water distillation still (for making pure water)
5. Test sieves
6. Nitrogen estimation apparatus (for estimating protein)
7. Microbial load counting apparatus (to count number of microbes per gram of food)
8. Sensitive balance
9. Colour reflectance meter (to measure colour of malt)

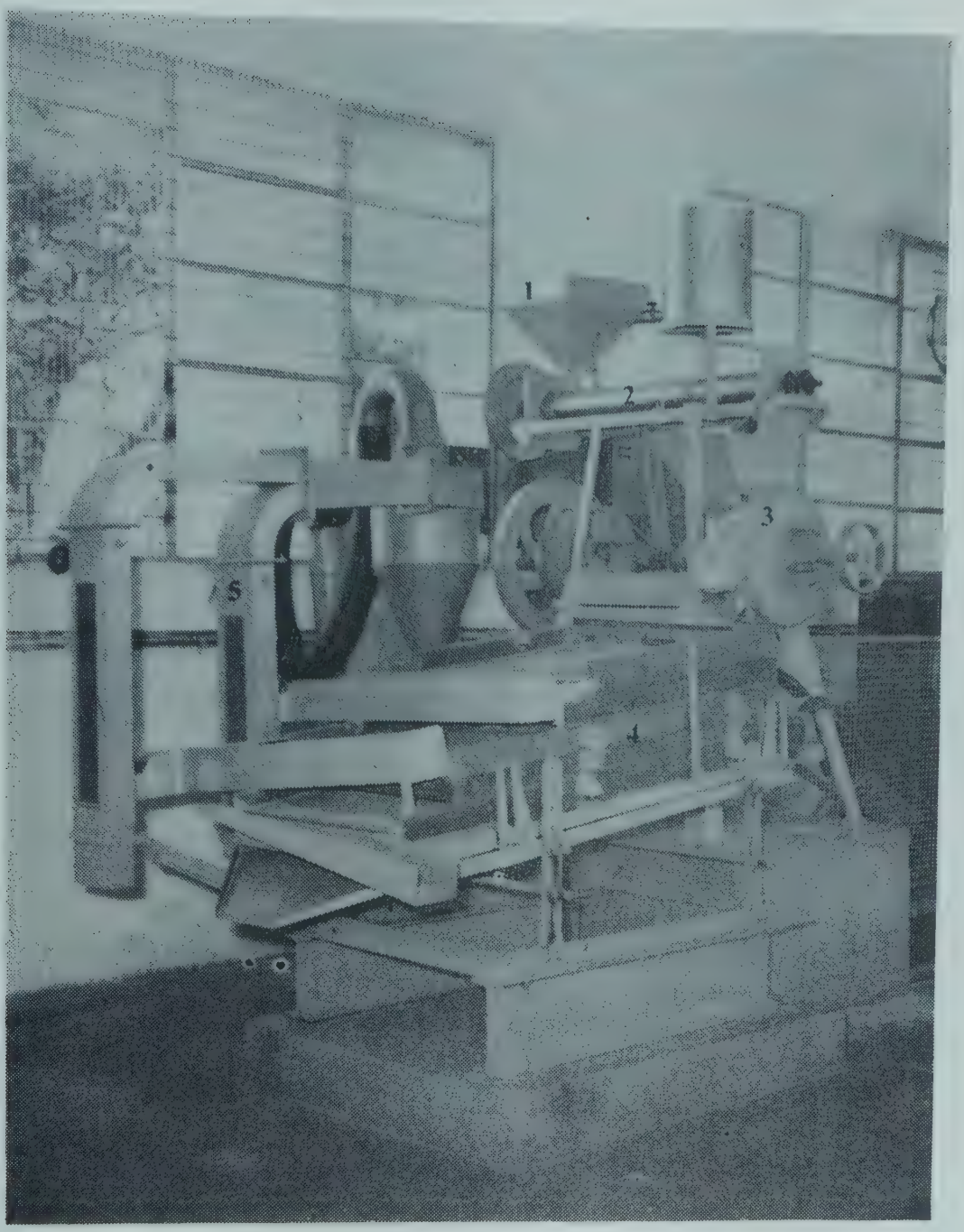


Figure 7. Mini grain mill

1. Feed hopper
2. Water mixture
3. Plate grinder
4. Sifters
5. Aspirator

It is ideal to provide a system to bubble air into the steeping tanks so that the accumulated carbon dioxide in the tank is driven off. Continuous flow of water and aeration hasten the process of germination. As indicated earlier, steeping for about 16 hours is enough. After draining the steep water, the grains should be spread on the floor or in germination trays/boxes. The temperature of the germination rooms should be maintained at about 25°C. Water should be sprayed to keep the grains moist.

Germinated grains or the sprouts may be dried in sun or in a mechanical dryer such as a truck dryer, through flow dryer, or fluidised bed dryer. Or the same germinating room may be converted into a drying chamber by passing hot air. This is possible if germination is carried out on trays. In case of mechanical dryer, the air temperature should be maintained below 70°C. After drying the grains to about 14% moisture the air temperature should be raised to 80-85°C for about one hour, so that kilning or curing of malt also takes place and the moisture content of the malt drops to about 6 per cent. The sprouts should be devegetated and then the grains taken for milling. In case sun drying is followed, as mentioned earlier, dried sprouts should be devegetated and kilned in a coffee roaster. Then the moist conditioning, grinding and sieving technique as explained earlier should be used to obtain debranned malt flour. Mixing of ragi malt flour, vitamin premix and minerals may be carried out in a flour mixer. After mixing, the food should be packed in polypropylene lined bags or tins for bulk storage, or in unit pack. pouches for distribution. During the various unit operations after kilning, care should be taken to avoid cross infestation for longer storage of food. However, it is advisable to fumigate the packed material before bulk storage or transportation. Or the food may be stored at a cool temperature (8-10°C) for longer shelf-life.

By-products: The floatings during steeping, the rootlets or the vegetative portion, husk and bran from the two grains are the by-products of this weaning food industry. These can be used in animal and poultry feed formulations. The effluent or the steep water may be utilised for irrigating garden/agricultural fields.

MALTING OF OTHER GRAINS

Besides ragi, other cereals like wheat, jowar, bajra and rice, and pulses other than green gram like cow pea and bengal gram can also be malted and used in weaning foods preparation.

The cereals should be washed and steeped in water for 16-24 hours, changing the steep water once or twice. It is better if the last steep is given in a weak solution of lime or caustic alkali. This reduces the occurrence of mould growth during germination and may be especially necessary with jowar and bajra. The optimum germination time varies from grain to grain. Two days germination may be sufficient for bajra, whereas rice, jowar and wheat may need slightly longer germination period.

Germination, drying and devegetation methodologies for these grains are same as described for ragi and green gram. Jowar and wheat require slightly longer time of kilning as compared to ragi. Kilned grains should be sprayed with about 3-4% water and milled similar to ragi to obtain malt flour. The malted grains from these could be de-branned in a rice huller or barley pearler. But while doing so a considerable portion of enzyme rich valuable malt is lost with pulverised bran. Therefore pearling of malt is not advisable. However, in case of malting of rice the sprouted paddy should be dehusked in a rice sheller (huller, rubber roller sheller or disc sheller). Rootlets are also removed along with husk. The brown rice malt is then kilned and powdered to prepare malt flour because debranning or polishing of brown rice malt is rather difficult in rice polishers. The malt flour contains a small portion of bran but it does not affect its food quality. However, if facilities are available, debranned malt flour could be prepared using the roller flour mill commonly used for wheat milling.

Cereal malt flours thus prepared are mixed with malted green gram or cow pea flour in the ratio of 2:1 respectively. The blends are the weaning foods. The foods may be mixed with sugar, milk powder, vitamins and minerals, if desired. Although, the food formulations from all these cereals are equally nutritious, based on the consideration of taste, flavour and keeping qualities, wheat based food shows high promise.

Preparation of Weaning Foods based on Some Other Simple Traditional Technologies

As discussed at the beginning, most mothers feed their babies with the food that adults eat in the house. But, it is desirable to enhance the nutritive value, calorie density and improve the texture of the adult food for feeding the same to the babies. The common food materials eaten in homes such as chapati, roti, savia or vermicelli and popped and flaked cereals can be improved in their protein content and quality by blending them with suitably processed legumes. The blends can be dried for longer storage and can be conveniently used like any other weaning foods.

Chapati/roti based weaning food

Generally flours for chapati or roti are prepared by grinding the grains and sieving off a small portion of the coarse bran. But flours prepared in this way contain rather high levels of fibrous bran. Therefore it is better to polish the grains and use the debranned or polished flours for preparation of weaning foods, so that the fibre content of the final product is low. For polishing wheat, maize, jowar and bajra, sprinkle 2-4% extra water, mix well, temper (heap up) for 10-15 minutes and pass through a rice huller or rice polisher. The flours prepared from polished grains are almost free from bran. Alternatively, the grains can be moistened and then powdered so that the course bran husk is easily separated by sieving. The resulting flours would still contain small amounts of bran, but that would not seriously affect the quality of the food formulations. Green gram flour alone or a mixture of green gram and bengal gram flours may be used as legume ingredients. However, it should be noted that malted legume flours (used for preparation of malted weaning foods) are not suitable for making chapati/roti based weaning foods. Chapati/roti needs baking. Baking spoils the taste and reduces the nutritive value of malt. Hence, malted grains should not be used for chapati/roti based food preparation. Preferably toasted or popped legumes could be used. Toasting and popping improve taste and flavour. Thus toasted green gram or popped bengal gram dhal flours may be used. Cereal flours blended with toasted green gram flour in the ratio of 70:30, or 70% cereal flour mixed with 20%

toasted green gram dhal flour and 10% popped bengal gram dhal flour should be used for making chapati/roti. Addition of popped bengal gram dhal flour improves taste and palatability of the food (see Figure 8).

Chapati/roti prepared from the above mixtures are tasty and nutritionally balanced. Fresh chapatis/rotis contain 25-35% moisture, and therefore cannot be stored as such. They can be soaked in milk to soften or mashed to feed the child immediately after preparation. But if these are to be stored for a few more days, they have to be dried to 6-8% moisture. Drying can be done in sun in a hygienic way or can also be done on the baking pan itself at a low temperature. Dried chapatis can be powdered, packed in tins and stored for use as and when required. When the powdered meal is added to water or milk and cooked for a short time, a soft paste is obtained. Such formulations may serve as a ready to eat mix for old and sick people also. This technique should be of wide practical use, for chapati/roti is being made in each and every home in India. No sophisticated machinery or special skill is needed. The process also allows the use of a wide range of cereals and legumes. Addition of milk powder to the dry food enhances its taste and nutritive value. The process can be commercialised using the facilities available at baking establishments.

Savia (Vermicelli) based weaning food

Generally Savia or vermicelli is prepared from wheat, rice, jowar, maize or millet flours alone. Similar to chapati food, if vermicelli is prepared from a blend consisting of polished cereal and legume flours, the product will be quite nutritious and can be used as weaning food. The mixture of flours should be prepared similar to that described for chapati food. Dough should be either steamed and pressed through (extruded) a perforated die of a hand operated press. The strands are called savia or vermicelli and are ready to eat. Alternatively, the dough may be extruded and the strands steamed or cooked. For storage, the strands should be dried. For drying, sun drying or hot air drying can be used. The dried vermicelli should be powdered and stored (see Figure 8). The food mixes well with water or milk and becomes a soft mass. Jowar and rice are more suitable as the major ingredient, for preparation of this food.

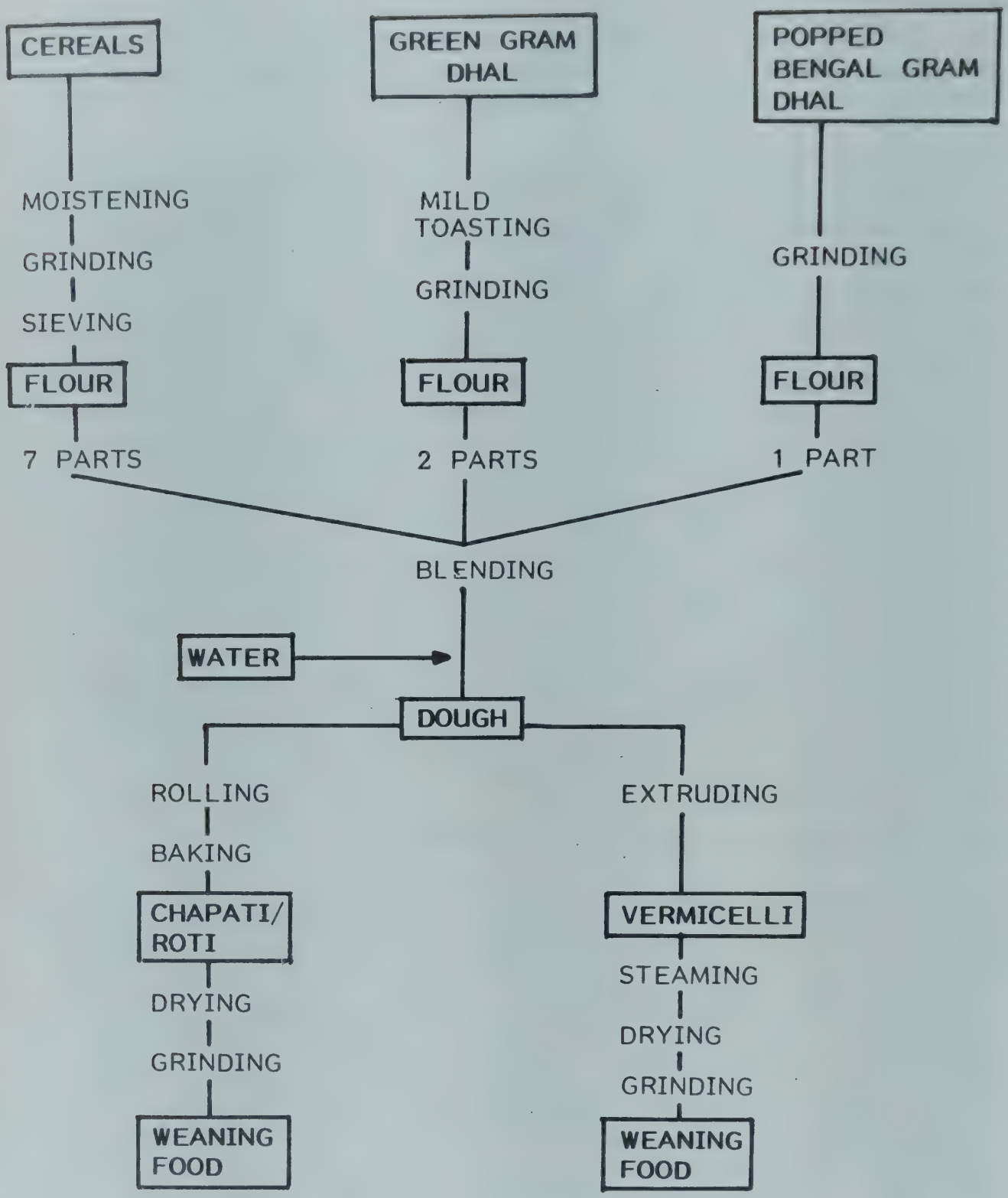


Figure 8. Flow chart for preparation of weaning foods based on chapati and vermicelli processes.

Rice flakes based weaning food

Rice flakes (Avalakki, Poha or beaten rice) are regularly used as snack food in rice growing areas in India. Flakes are precooked and ready to eat products and are an ideal raw material for preparation of weaning food formulations. Rice flakes are readily available in market. Or they can be prepared in homes also. Cleaned flakes should be toasted mildly to lower their moisture content and increase their crispiness, and then powdered. The flour (70%) should be mixed with toasted green gram flour (20%) and popped bengal gram flour (10%) to make the weaning food (see Figure 9). The food is of soft texture and possesses good taste and flavour. Although the ingredients of this food are ready to eat products, the food should be cooked in water or milk before feeding. This process is one of the easiest ways to make weaning foods at home.

Popped cereal based weaning food

Popped or puffed products from cereal grains such as pop corn, popped jowar, puffed rice or expanded rice (Puri or Murmura) are sold in the market. Popped ragi flour is also marketed in some places. These are generally used as snacks. These are also ready to eat products. Popped cereals can be used as a base material for weaning food formulations. For weaning food formulation, either popped products obtained from market may be powdered and used or these can be prepared at home. For preparation of popped cereals, the grains are moistened (a small amount of water is sprayed and the grains are heaped for some time) and then agitated in hot sand or salt for a short time. The popped grains should be immediately separated from the hot sand/salt. Unpopped grains should be separated from the popped grains. If popping is done in hot sand, a few sand particles may adhere with the popped grains and affect the product, whereas when popping is done in hot salt, even if some salt particles stick, it does not affect its eating quality.

Popped grains should be powdered immediately and blended with toasted green gram and popped bengal gram flours in 70:20:10 proportion respectively (see Figure 9).

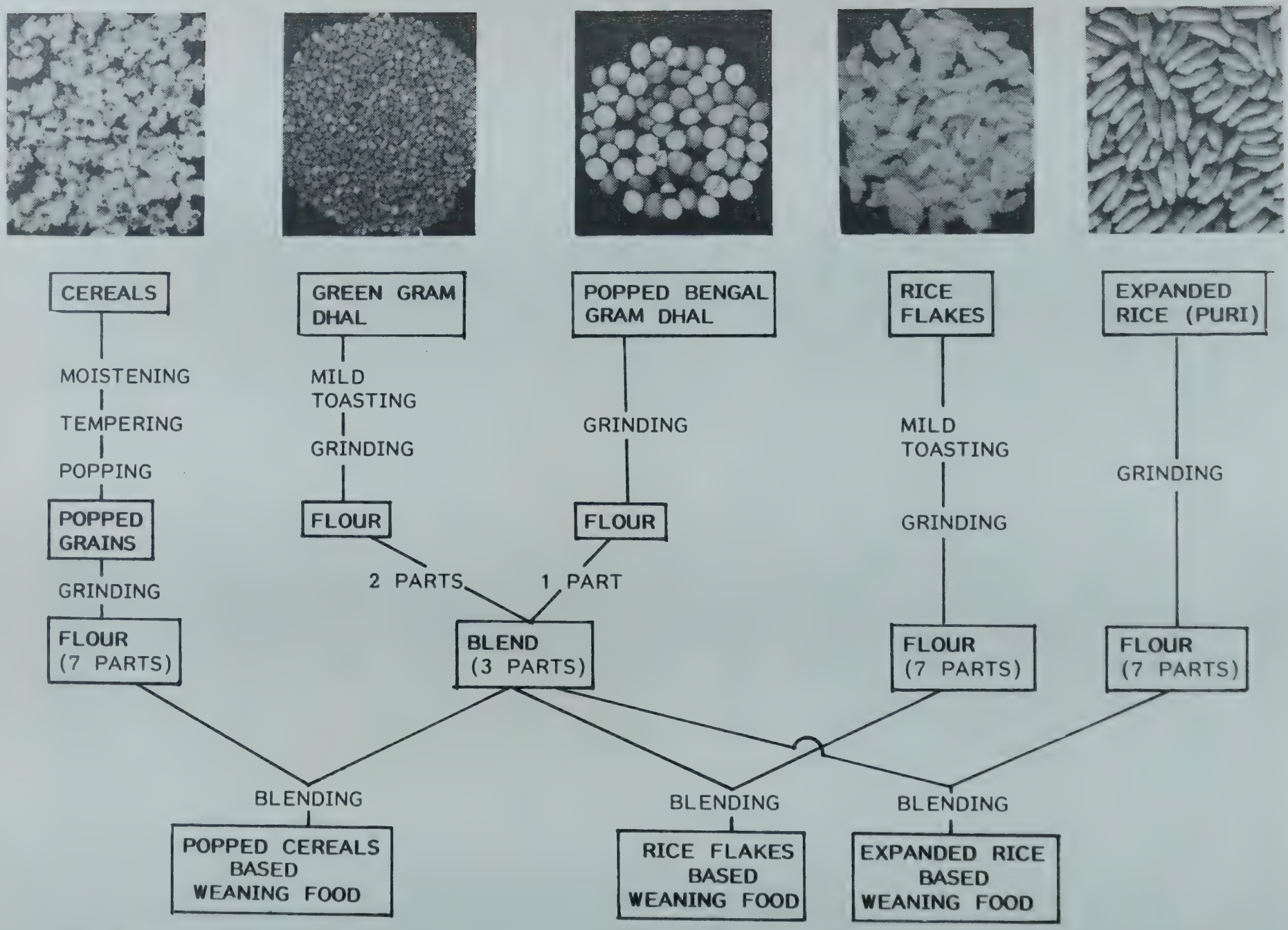


Figure 9. Approaches to prepare weaning foods based on popped, flaked, expanded cereals and legumes

Popped cereal based weaning foods are hygroscopic (absorbs moisture) and become soggy when exposed to atmosphere. Hence these have to be stored in closed tins. Since it is difficult to debran popped grains or to pop the dehusked grains, the fibre content of the popped cereal based formulations is generally high. Therefore this type of food is more suitable for a slightly older children or to pre-school children. The bulk of the food is also very high, hence it needs more packaging materials. If expanded rice or puri is used as a base material, the fibre content of the food is not high as paddy is cooked, polished and then popped. Popping is a very simple process Basically it is a dry process. It can be applied to a wide range of cereals. The process does not require sophisticated equipments. It can be done at homes also. Popped products possess agreeable and pleasant aroma.

Banana based weaning food

Feeding banana or plantain to weaning children is generally practiced extensively in Kerala and Assam and also in many African countries. Normally a special variety of banana (Nendra) is used for this purpose. Mashed and cooked banana pulp is mixed with rice, and given to the child. Instead, if banana, that is just ripe or nearing ripeness is peeled and the pulp is sliced, cooked in thin rice gruel, dried and powdered, one gets a banana flour which can be stored for some time. The banana flour may be mixed with processed cereal (malted, popped, expanded, flaked) and legume (toasted, popped) flours as indicated in Figure 10, to prepare the weaning food formulations.

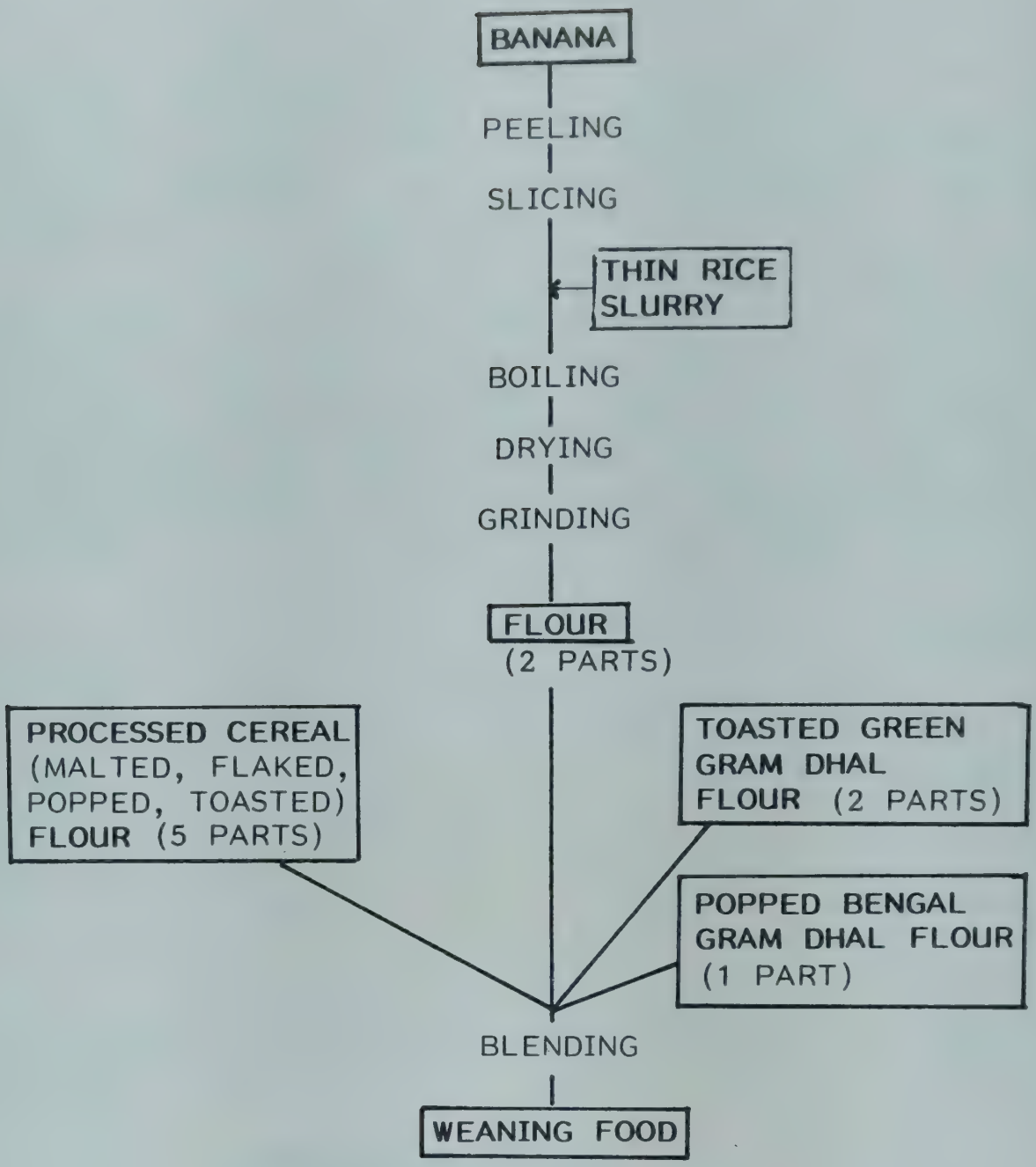


Figure 10. Flow chart for preparation of banana based weaning food

METHODS TO REDUCE THE DIETARY BULK OR VISCOSITY OF WEANING FOOD SLURRY

As has been explained earlier, it is desirable that the weaning foods should not absorb too much water and should not become bulky when the food is stirred up and cooked with water or milk. The slurry or paste should be thin and should contain a high amount of food solids. But the ready to eat weaning foods available in the market or the weaning food formulations that are prepared from roller drying, extrusion cooking, chapati & savia processes, or using popped and flaked cereals do not posses this desirable quality. They absorb a large amount of water and swell up greatly when mixed and cooked with water or milk, giving a very bulky paste of low calorie density.

This problem of high bulk can be overcome by a simple technique. If some source of starch hydrolysing enzymes is added to the food as an adjunct, it will help to reduce the bulk. The dry blends of weaning foods could be mixed with a small quantity of cereal malts (about 10% of ragi, jowar or wheat malt or about 2% of barley malt). When the food containing malt is stirred with warm water or milk, or cooked slowly, the malt enzymes will break down the starch and reduce the viscosity (that is, it will thin down the paste). Addition of malt flour to weaning food formulations does not affect their keeping quality or nutritive value. It will not increase the price of the food also as cereal malts are not very expensive. The malt flour could be mixed with the proprietary weaning foods and those prepared by traditional technologies before packaging. Alternatively, mothers can add a small quantity of malt flour while preparing the food for feeding the child. At commercial levels, instead of malt flours, fungal alpha-amyalse at a level of about 0.2% may be added.

RECOMMENDED STANDARDS FOR WEANING FOODS

The cereal based infant food shall be in the form of powder, small granules or flakes, free from lumps and shall be uniform in appearance. It shall be free from dirt and extraneous matter and free from preservatives, added flavours and added colours. It shall not contain any added fat other than the fat derived from materials used in the preparation of the product. It shall be free from any material and bacteria which are harmful to human health.

The flavour and odour of the complementary cereal based infant food in the powder form or when reconstituted with water shall be fresh and sweet. It shall not have a rancid taste or a musty odour.

The processed cereals weaning foods and the milk-cereal based weaning foods shall comply with the requirements given in Tables 5 and 6.

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Table 5. Requirements for processed cereal weaning foods

Sl. No.	Characteristics	Requirement
1.	Moisture, percent by weight, max.	10.00
2.	Total protein (Nx6.25), percent by weight,min.	14.00
3.	Fat, percent by weight, max.	7.50
4.	Total carbohydrates, percent by weight,min.	45.00
5.	Total ash, percent by weight, max.	5.00
6.	Ash (insoluble in HCl), percent by weight,max.	0.05
7.	Crude fibre (on dry basis), percent by weight, max.	1.00
8.	Vitamin A, IU/100 g, min.	1500
9.	Vitamin C, mg/100 g, min.	25
10.	Added vitamin D, IU/100 g.	300-800
11.	Thiamine (as hydrochloride), mg/100 g, min.	0.50
12.	Riboflavin, mg/100 g, min.	0.60
13.	Nicotinic acid, mg/100 g, min.	5.00
14.	Calcium, g/100 g, max.	1.00
15.	Iron, mg/100 g, min.	10.00
16.	Bacterial count per g, max.	50,000
17.	Coliform count per g, max.	10

Source: Specification for processed cereals weaning foods (First revision) IS:1656-1969

Table 6. Compositional specifications for milk-cereal based weaning foods

Sl. No.	Characteristics	Requirement
1.	Moisture, percent by mass, max.	5.0
2.	Total protein, percent by mass, min.	12.0
3.	Fat, percent by mass, max.	7.5
4.	Total carbohydrates, percent by mass, min.	55.0
5.	Total ash, percent by mass, max.	5.0
6.	Acid insoluble ash, percent by mass, max.	0.1
7.	Crude fibre (on dry weight basis), percent by mass, max.	1.0
8.	Vitamin A (as retinol), mcg/100 g, min.	350.0
9.	Vitamin C, mg/100 g, min.	25.0
10.	Added vitamin D, mcg/100 g	300-800
11.	Thiamine (as hydrochloride), mg/100 g,min.	0.5
12.	Riboflavin, mg/100 g, min.	0.6
13.	Nicotinic acid, mg/100 g, min.	5.0
14.	L-ascorbyl pamitate, mg/kg fat, max.	200.0
15.	Iron, mg/100 g, min.	5.0
16.	Bacterial count per g, max.	50,000
17.	E. coli count per 0.1 g	Nil

Source : Specification for milk-cereal based weaning foods (Second revision) IS: 1656-1985


WEANING FO
PAL FOOD TECHNOLOGICAL RESO

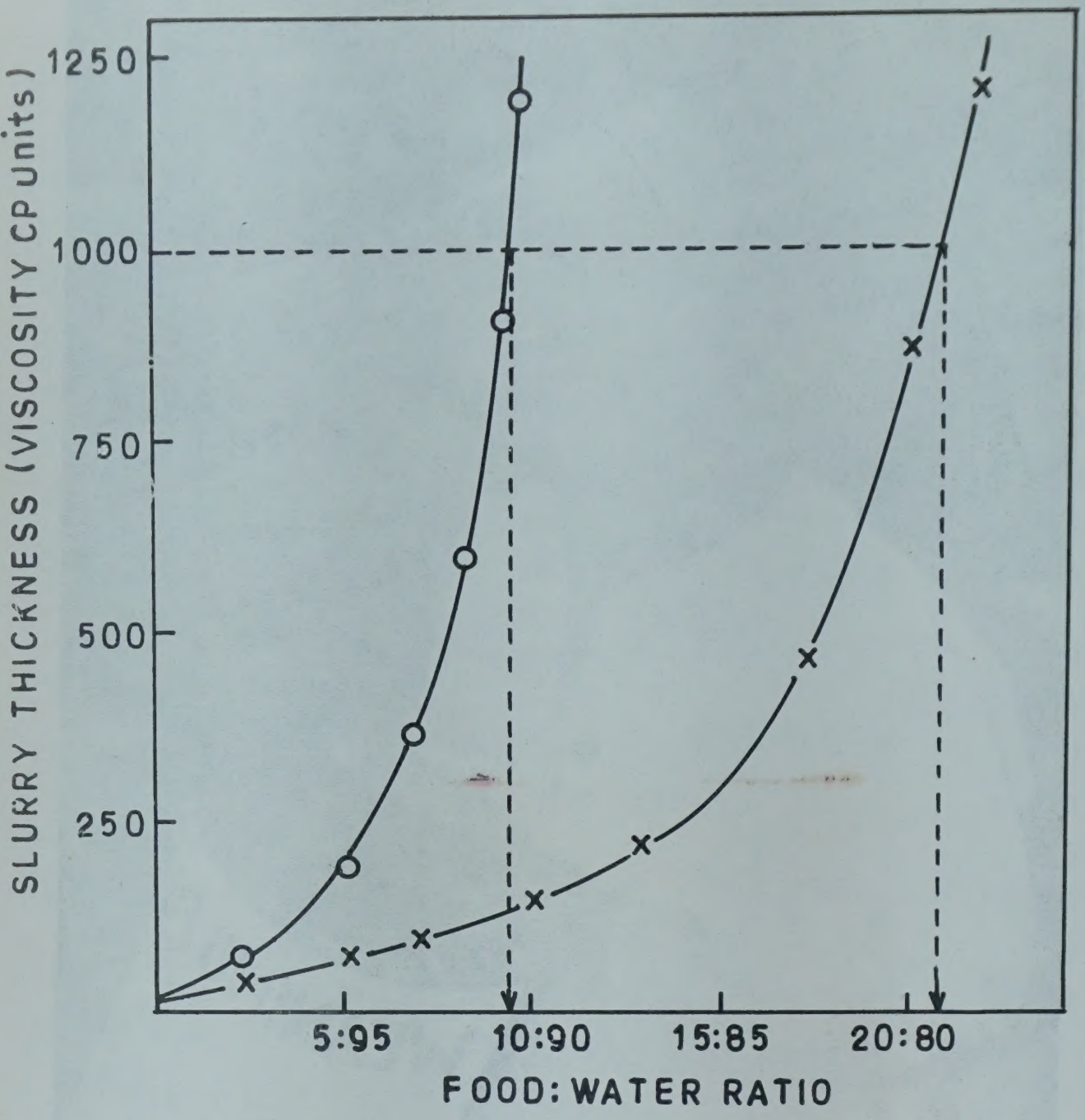

FIGURE INDICATING THE ACTUAL FOOD CONTENT IN SLURRIES OF EQUAL CONSISTENC

—o— ROLLER DRIED WEANING FOOD

—x— MALTED WEANING FOOD / ROLLER DRIED FOOD CONTAINING MALT FLOUR

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